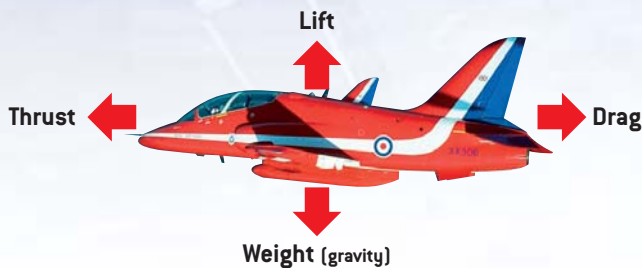


Getting Flying with TEP

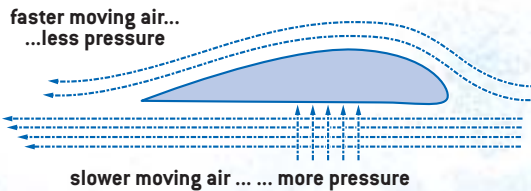
With the resurgence of interest in flight during the centenary year of powered flight it seemed a good idea to look at the TEP 'Air motors' and get them airborne. Model flying and building has held little attention in recent years partly due to cost of materials, disappearance of model shops and due to other high-tech distractions which are also getting expensive for pupils! The wealth of science, maths and practical D&T opportunities that can be followed up are staggering. So this issue Kieron McGeever starts an occasional series of articles on flight and model flying.

Principles of flight

Any aircraft flies because its wings produce more Lift (upwards force) than its total Weight (downwards force) due to gravity. The lift produced by the wings is dependent on the speed of the air over the wings caused by the Thrust of the motor overcoming the Drag of the air on the plane.

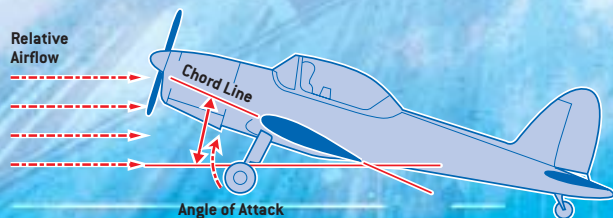
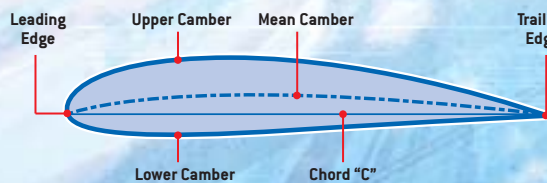


Wings can be designed to give high or low levels of lift. The more lift a wing produces the greater the drag it produces. The more drag a wing produces the slower the aircraft will fly for any given motor and therefore the less lift the wing will be able to produce. In full size aircraft this problem is overcome by fitting a very powerful light weight motor, but for model aircraft you can now begin to see the problem.



Wings, Lift

It is the aerofoil shape of the wing that produces the lift. A symmetrical wing shape will give no lift when presented horizontally to the air flow and the more you reduce the underside curvature of the wing the more lift it will start to produce. A concave shape on the underside of the wing will give the highest lift, but also the highest drag factor. The angle that you present the wing to the airflow will also affect the lift of the wing. The higher you tilt the leading edge of the wing (known as the angle of attack) the more lift will be produced for a given airspeed, but this will also increase the drag factor. The maximum practical angle of attack for a model is about 8 degrees to the horizontal.



Air Motors, Thrust

There are two air motors designed to use for model flying in the Teaching Resources catalogue. The blue motor has an output of 32gf (grams force) for 15 seconds and the green motor 71gf for about 10 seconds. The motors have to be powerful enough to overcome the drag of the aeroplane so that it will move forward with enough speed to produce sufficient lift on the wings to overcome the models weight. Both motors have unusual shaped bottles for their compressed air supply and so present some interesting constructional challenges in building an airframe around them.

Materials

The materials that you make a flying model from should be as light weight as possible.

The traditional materials are balsa wood and tissue paper, but modern materials such as expanded polystyrene, modelling card and corriflute are easier to use and more readily available, along with split cane which is very cheap and provides a large quantity when purchased as a roller blind from a home hardware store.

These materials will work with standard glues such as PVA and Hot glue guns to make quick strong joints. They also can be successfully joined with mechanical fixings.



Materials
Split cane, glue, plastic sheet, Expanded polystyrene.

Methods of Construction

The construction of a flying model does not have to be complicated and the simpler it is the better. Materials need to be kept to a minimum to keep the overall weight of the model as low as possible. A good approach is to make your first design and then see just how much of the material you have made it from, you can cut away without the model falling apart.

Fuselage

There are various ways of making a fuselage for one of the TEP air motors using just corriflute or in combination with other materials such as split cane. Corriflute can be cut into net shapes and then bent into shape by cutting through the top layer and then bending. This forms a very strong joint and the corriflute can be cut into complicated shapes using a Hot Wire Cutter.

Split cane can be joined to the corriflute by sharpening the end and then pushing it through or into the holes in the end of the sheets. A drop of PVA glue on the cane will then hold it firmly in place.

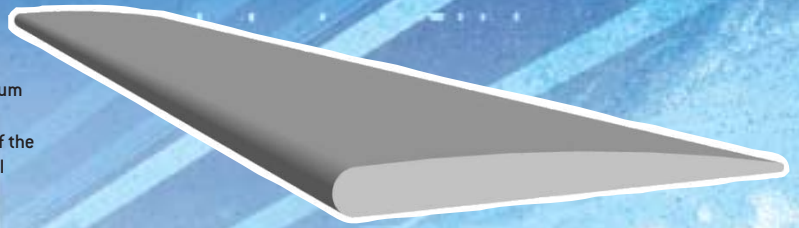
Tail

The tail plane and fin of the fuselage can be made from flat boards as they are not needed to produce lift but to stabilise the flight of the model. They must be perpendicular to the rest of the fuselage. The body of the model does not want to be too long as this will increase weight and make the centre of gravity to far back from the propeller.



Wings

It is important to use a simple and lightweight way of making the wings for the model. The traditional way is to use balsa wood formers, glue them together to form a skeleton and then cover it with tissue or plastic sheet. This is time consuming and requires a lot of skill and patience. Wings can also be made from slabs of expanded polystyrene on a horizontal hot wire cutter by sticking an aluminium profile of the aerofoil shape on each end and then pushing it over the hot wire. ➡



The greater the camber of the aerofoil shape the more lift the wing will produce for a given air flow, but also a higher drag factor, so the shape is a compromise between lift, drag and the inherent strength of the wing.



A longer wing will need a thicker cross section for stiffness. Wings can also be made from flat sheets of decorative polystyrene laminated together, utilising the natural curve of the sheet as it comes off the roller to give the aerofoil shape. Two layers on the top of the wing give a very stable and light weight shape. A flat sheet on the bottom stiffens the whole wing.



There will certainly be lots of crash landings and crash damage during development so an important strategy is to not have the wings permanently fixed to the fuselage but rather, to use an elastic band or two allowing the wing to detach without damage when contacting solid ground, trees or buildings! Wing tips will also be the most vulnerable part in those crashes so making them more crash resistant is a good ploy.



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Getting Flying with TEP

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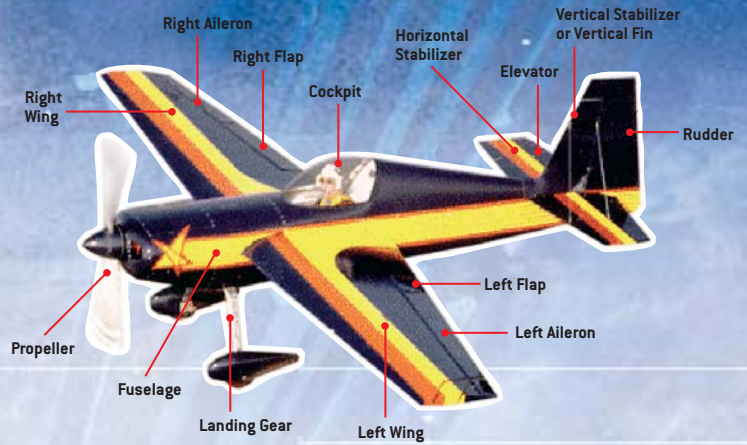


Hot Wire Cutter

Contrary to popular belief, hot wire cutters are not dangerous if used with the usual amount of caution applied to all equipment used in a workshop. If the voltage of the wire is set so that it does not over heat the polystyrene to the point where it visibly fumes and good ventilation is used then there will be no dangerous build up of toxic gases, but it is a good idea to familiarize yourself with the COSH regulations from CLEAPSS before using one in your workshop.



This cutter is made from MDF and utilises an AC 12 volt transformer for spot lights to power it. The wire is made from resistance wire with a value of 3 to 4 ohms per metre. The temperature of the wire can be adjusted by making it longer to cool it or shorter to make it hotter. About 600mm is a good starting point for getting the right temperature. We plan to feature its construction in a future article.



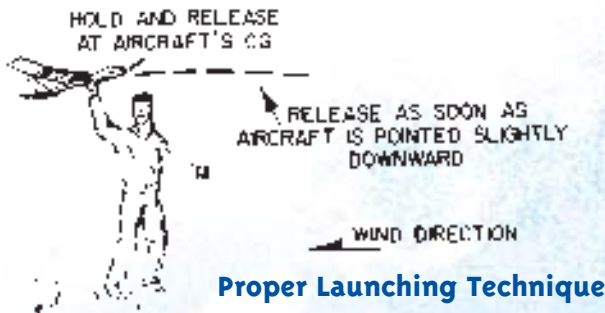
How to achieve a successful flight

Centre of Gravity

It is very important to get the centre of gravity of the model correct to achieve a successful flight. Start by balancing the wing on two points at the tips. The wing should balance about one third from the leading edge of the wing. Mark this point with a line along the length of the wing. Then balance the fuselage complete with the tail plane in a similar manner and mark this with a line across the fuselage. Fit the wing to the fuselage in the centre of the wing with the lines coinciding. Put the wing back onto the two balance points and the whole model should be in balance with the tail plane horizontal and the fin vertical. Test fly your model in the following manner.

When you have achieved the correct flight path pump up your motor and try a powered flight. If this works then you can trim your model to make it fly just the way you want it by adding small control surfaces to the wings and tail to make it climb or fly in a circle. The ultimate would be to make the model fly for as long as possible.

Building and flying model aircraft is a fascinating topic that utilises a lot of construction skills and applying a little Maths and Science to make a successful model. This article has not tried to tell you how to make a particular model but hopefully it has pointed out how to design and build your own with the starting point of one of the TEP air motors. They require only compressed air from a hand pump and have zero running costs.



Proper Launching Technique



Aircraft is Tail-heavy or was launched too hard

A lot of research has gone into getting this far and is continuing, it has been fun and watch out for further articles.



Correct Flight Path

